# Subsurface Barrier Validation with the SEAtrace™ Monitoring System

## Technology Need:

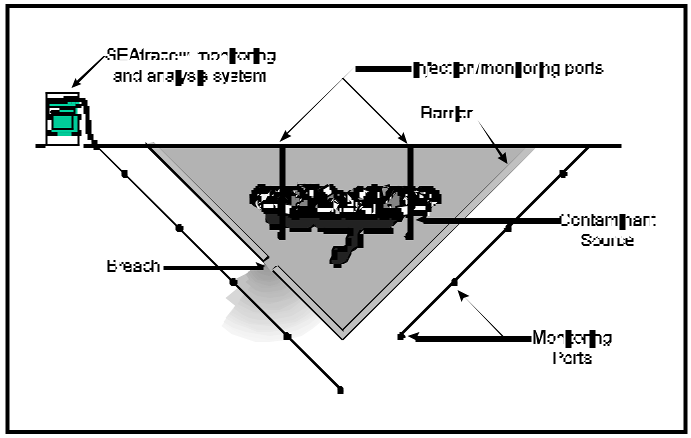
In situ barriers for the containment of high-risk contaminants in soils are currently being developed by the Department of Energy (DOE). These include slurry walls, grout barriers, cryogenic barriers, and other forms of impermeable barriers. Because of their relatively high cost, the barriers are intended to be used in cases where the risk is too great to remove the contaminants, the contaminants are too difficult to remove, or the potential for movement of the contaminants to the water table is so high that immediate action needs to be taken to reduce health risks.

Assessing the integrity of the barrier once it is emplaced, and during its anticipated life, is a very difficult but necessary requirement. Current methods include hydraulic tests and geophysical methods. The need exists for methods to evaluate the performance of the containment systems and monitor the long-term integrity of the installations.

## Technology Description:

Science and Engineering Associates, Inc. (SEA) developed an integrated, real-time, gaseous-tracer-based monitoring/verification system. This system, called SEAtrace™, is able to locate and size leaks with a high degree of accuracy for subsurface barriers which are located in an unsaturated medium. SEAtrace™ uses gaseous-tracer injection, in-field real time monitoring, and real-time data analysis to evaluate barrier integrity.

SEAtrace™ is predicated on the very simple and predictable transport process of binary gaseous diffusion in porous media. Diffusion is an attractive process to utilize for leak detection because the tracer concentration histories measured at locations distant from the source are highly sensitive to both the size of the breach and the distance from the leak source. This sensitivity allows a




global optimization inverse modeling methodology to iterate to leak geometry and location by minimizing errors in the transport calculations. Thus SEAtrace™ is made up of two distinct functional components: a monitoring system and an optimization code.

Monitoring is accomplished with a self-powered, autonomous soil-gas sampling and analysis system which incorporates an infrared gas analyzer. Multiple sample points are located outside the barrier, as well as one or more injection and sample ports inside the barrier. These ports are connected to the gas sampling and analysis system. A tracer gas (typically sulfur hexafluoride [$SF_6$]) is injected into the barrier, creating a large source volume of the tracer. If the barrier has a breach, the tracer will diffuse into the surrounding medium and the exterior vapor ports will sample the soil gas for real-time analysis.

Resulting concentration histories at each of the sample locations, along with soil medium properties, are provided to the global optimization code. The code then iterates to find a best fit solution given the input parameters. The integrated system will produce real-time analysis of leaks within several hours of data collection.

## Benefits:

<Provides early detection by measuring vapor leaks in containment systems where the greatest risk

<Applicable to any impermeable barrier emplaced in the unsaturated zone

<Inexpensive: uses readily available, non-toxic gaseous tracers; does not require an inordinately large number of sampling points; and injection and sampling points can be emplaced by direct push techniques

<Capable of both assessing a barriers' initial integrity and providing long-term monitoring

## Status and Accomplishments:

This project was completed in September 1999. Pilot-scale tests of the SEAtrace™ system were conducted at a test site in Waldo, NM during the base phase of the project (1997). A mock-up barrier scaled large enough to represent a typical installation, was constructed with engineered leaks (emplaced or formed leaks of known size and location). Results of this initial testing showed that the system was capable of locating and sizing leaks in barrier installations. Leaks as small as 1.1 cm diameter (0.95 $cm^2$ area) could be detected with a positional accuracy of 0.4 to 1.2 meters.

SEAtrace™ system was demonstrated at the Dover Air Force Base (AFB) Groundwater Remediation Field Laboratory during June and July 1997 to evaluate two test barrier installations and two engineered leaks. The SEAtrace™ operation located three discrete flaws in each of the two barriers along with the engineered leaks within 0.3 meters of their known locations and within 0.3 meters of their actual size.

SEAtrace™ was demonstrated during August and September 1997 to evaluate the integrity of a colloidal silica barrier that has been emplaced at Brookhaven National Laboratory. The system detected seven leaks around the barrier. The fully automated system calculated leak characteristics (sizes ranged from 0.4 to 1.1 m diameter) within 30 minutes of data collection. Operators accessed the system remotely to retrieve data.

SEAtrace™ was demonstrated at Brunswick, Maine Naval Air Station (NAS) over a period from February through June 1999. In the field demonstration, a 100-foot section of a slurry wall, installed at a landfill, was monitored to a depth of 20 feet, for a period of approximately 5 weeks. No breaches were detected in the barrier, however, gaps between the barrier and the Resource Conservation and Recovery Act (RCRA) cap were identified.

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## Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 308
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov

An Innovative Technology Summary Report (ITSR) for this technology can be viewed at http://apps.em.doe.gov/ost/pubs/itsrs/itsr308.pdf

For more information on this and other technologies, please visit SEA's website at http://www.seabase.com